GEAR TRANSMISSION UNIT WITH PLANET CARRIER

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WO9611338
DE2235448
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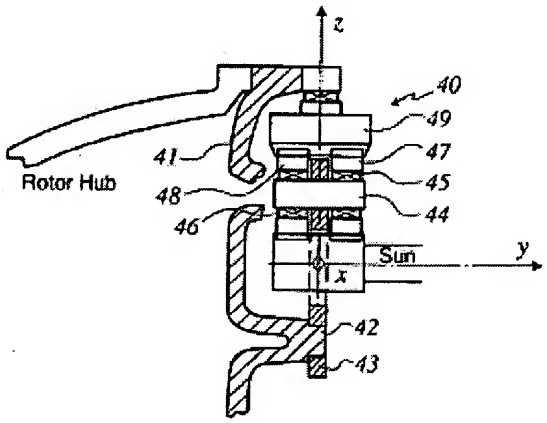
Abstract of **WO2004013516**

A planetary type gear transmission unit suitable for a wind turbine comprises sun (27), planet (25) and ring (24) gears and a planet carrier (41), the planet carrier comprising a planet bogie plate (43) which supports and locates circumferentially spaced planet gear bearings (45, 46) on which the planet gears are mounted, and at least some of said bearings (45, 46) being cylindrical roller bearings.



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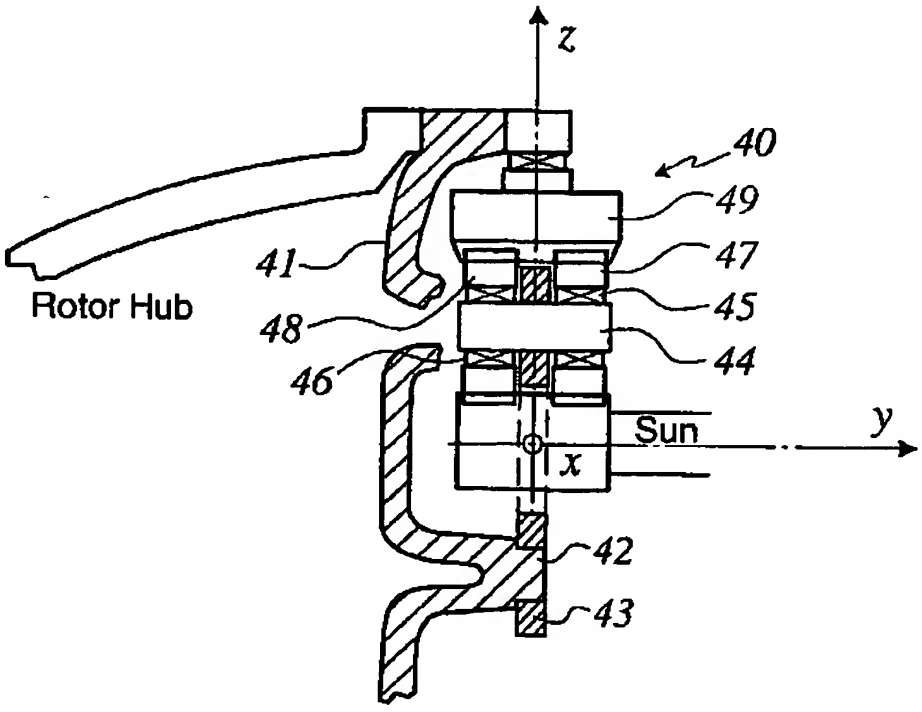

(57) Abstract: A planetary type gear transmission unit suitable for a wind turbine comprises sun (27), planet (25) and ring (24) gears and a planet carrier (41), the planet carrier comprising a planet bogie plate (43) which supports and locates circumferentially spaced planet gear bearings (45, 46) on which the planet gears are mounted, and at least some of said bearings (45, 46) being cylindrical roller bearings.

WO 2004/013516 A1

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

GEAR TRANSMISSION UNIT WITH PLANET CARRIER

This invention relates to a planet carrier for a gear transmission unit and in particular, though not exclusively, to a planetary type gear transmission unit. It may be applied to a gear transmission unit for a wind turbine.

There is a continuing demand for larger wind turbines especially for offshore sites due to scarcity of suitable sites and cost of civil works. At the same time the requirements for reduction of size and weight of the machines and their components become more and more important. Typically a wind turbine rotor drives the low speed shaft of a gear transmission unit, which transforms torque and speed of the rotor to the required torque and speed of an electrical generator.

Integration of the components in a wind turbine is a way to reduce the weight and to make the drive assembly more compact, but it is important that the design and execution of the drive assembly avoids mutual interference of the external and internal loads on the different components. It is also important that the construction of an integrated drive assembly allows effective lubrication to be achieved economically and reliably.

The present invention is directed particularly but not exclusively to the problem of providing an accurate and long life support for planet gears in a manner which is economical and which may be utilized on a wind turbine assembly.

In accordance with one aspect of the present invention a planetary type gear transmission unit comprises sun, planet and ring gears and a planet carrier, said planet carrier comprising a planet bogie plate which supports and locates circumferentially spaced planet gear bearings on which planet gears are mounted, and at least some of said bearings being cylindrical roller type bearings.

CONFIRMATION COPY

The gear unit may comprise planet gears which are arranged in axially aligned pairs.

The bearings may support respective pairs of aligned planet gears, typically the two gears of each pair being positioned at opposite sides of the plate.

The bearing(s) for each circumferentially spaced planet gear position may be supported on a shaft which in use is able to self adjust in said angular position relative to the bogie plate.

As considered in an axial direction parallel with the axis of rotation of the planet carrier, a main bearing for rotatably supporting a ring gear relative to a planet carrier lies at a position substantially aligned axially with the axial position of at least the ring gear of the gear transmission unit.

Preferably the sun, planet and ring gears lie in a transverse plane (perpendicular to the rotation axis of said rotational forces) which also contains said main bearing.

The ring gear may provide axial and radial locations for the main bearing. The ring gear may have a radially outer surface of a stepped profile to define a shoulder for axial location of an inner bearing ring of the main bearing. The inner bearing ring may be secured axially and non-rotatably between said shoulder a supporting structure.

The ring gear may be provided with a reinforcing ring, and said reinforcing ring may extend axially and or radially beyond the toothed surface of the ring gear. Said reinforcing ring may provide an axial location of the main bearing.

The main bearing may comprise a double taper bearing, and said double taper bearing may comprise a single outer bearing ring. The double taper bearing may comprise rollers arranged in an O configuration in which the rollers of one series increase in diameter in a direction away from the rollers of the other series of the pair.

In a yet further of its aspects the present invention provides a wind turbine comprising rotors, a generator and a drive assembly comprising a gear transmission unit of a type in accordance with the present invention. In said drive assembly the ring gear typically may be supported non-rotatably relative to supporting structure.

A part of the gear transmission unit, e.g. a housing thereof, may be arranged to support an electrical generator.

The invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings in which: -

Figure 1 is an elevation view of a wind turbine having a gear transmission unit of the present invention;

Figure 2 is a sectional view of part of a gear transmission unit;

Figure 3 shows part of Figure 2 in more detail, and

Figure 4 shows a particular feature of the present invention.

A wind turbine 10 (see Figure 1) comprises a gear transmission unit 11 which acts to transmit torque from rotor blades 12 and a rotor hub 14 to an electrical generator 13, the gear transmission unit comprising an epicyclic gear unit. The gear transmission unit and generator are housed in and supported by a nacelle 15.

The gear transmission unit 11 is now described in more detail with reference to Figures 2 and 3. The gear transmission unit 11 comprises an epicyclic gear unit having four circumferentially spaced planet gears 25, a sun gear 27 a planet carrier 28, and a ring gear 24 which is non-rotatably mounted relative to the nacelle structure 15.

The sun gear is connected to an output shaft (not shown) which connects either to a further gear unit or direct to the rotor of the generator 13.

The radially outer surface 29 of the ring gear 24 provides location and support for the inner ring 30 of a main bearing 23.

The outer ring 31 of the main bearing has secured thereto the rotor hub 14 and, interposed between the rotor hub and ring 31, the outer region 22 of the planet carrier 28.

In a prior proposed construction the planet carrier 28 of Figure 3 comprises four bearing support studs 26 uniformly circumferentially spaced to locate bearings 32 which rotatably support the four planet gears 25. The planet carrier 28 has an annular region 33 which extends radially between the radial position of the bearing studs 26 and the outer region 22 and is designed to be relatively stiff, in a circumferential direction about the Y axis, for transmission of torque between the region 22 and the bearing studs 26, but to be relatively flexible about the X and Z axis.

In accordance with the present invention the planet carrier 28 is replaced by a planet carrier 41 (see Figure 4) provided, in this embodiment, with three integral and uniformly circumferentially spaced studs 42 which support a planet bogie plate 43. The planet bogie plate 43 provides support for three circumferentially uniformly spaced shafts 44 arranged each (as viewed in the plane of Figure 4) to self adjust in angular position on the plate 43. Each shaft 44 provides support, at opposite sides of the plate 43, for a pair of cylindrical roller bearings 45, 46 about which each of a pair of planet gears 47, 48 are rotatably mounted for engagement with the ring gear 49.

In the aforedescribed construction the torque acting on the rotor hub 14 under action of the rotor blades 12 is transmitted to the planet gears 47, 48 via the planet carrier 41 rotatably mounted at is outer region to the outer ring 31 of bearing 23. Bending moments and axial forces in the Y direction exerted by the rotor hub in this construction are transmitted direct to the bearing 23. The flexibility of the annular portion 33 of the planet carrier 28 assists to substantially isolate those forces from the planet gears.

The present invention thus teaches, in its broadest aspect, that a bogie of a planet carrier is provided with roller bearings which are of the cylindrical type for the support of planet gears.

CLAIMS

1. A planetary type gear transmission unit comprises sun, planet and ring gears and a planet carrier, said planet carrier comprising a planet bogie plate which supports and locates circumferentially spaced planet gear bearings on which planet gears are mounted, and at least some of said bearings being cylindrical roller bearings.

2. A gear transmission unit according to claim 1, wherein it comprises planet gears arranged in axially aligned pairs.

3. A gear transmission unit according to claim 2, wherein the bearings support respective pairs of aligned planet gears.

4. A gear transmission unit according to claim 3, wherein two gears of each pair are positioned at opposite sides of the plate.

5. A gear transmission unit according to any one of the preceding claims, wherein the bearings for each circumferentially spaced planet gear position are supported on a shaft which, in use, self adjusts in said angular position relative to the bogie plate.

6. A gear transmission unit according to any one of the preceding claims, wherein, as considered in an axial direction parallel with the axis of rotation of the planet carrier, the ring gear is substantially aligned axially with a main bearing which supports the ring gear relative to the planet carrier.

7. A gear transmission unit according to claim 6, wherein the main bearing comprises an inner ring bearing surface of a diameter greater than that of the toothed surface of the ring gear.

8. A gear transmission unit according to claim 6 or claim 7, wherein the sun, planet and ring gears lie in a transverse plane which contains said main bearing.

9. A gear transmission unit according to any one of the preceeding claims wherein the planet carrier provides a radially extending torque transmissions path

which is torsionally stiff but relatively compliant in an axial direction parallel with the axis about which the rotational forces act.

10. A gear transmission unit according to claim 1, and substantially as hereinbefore described.

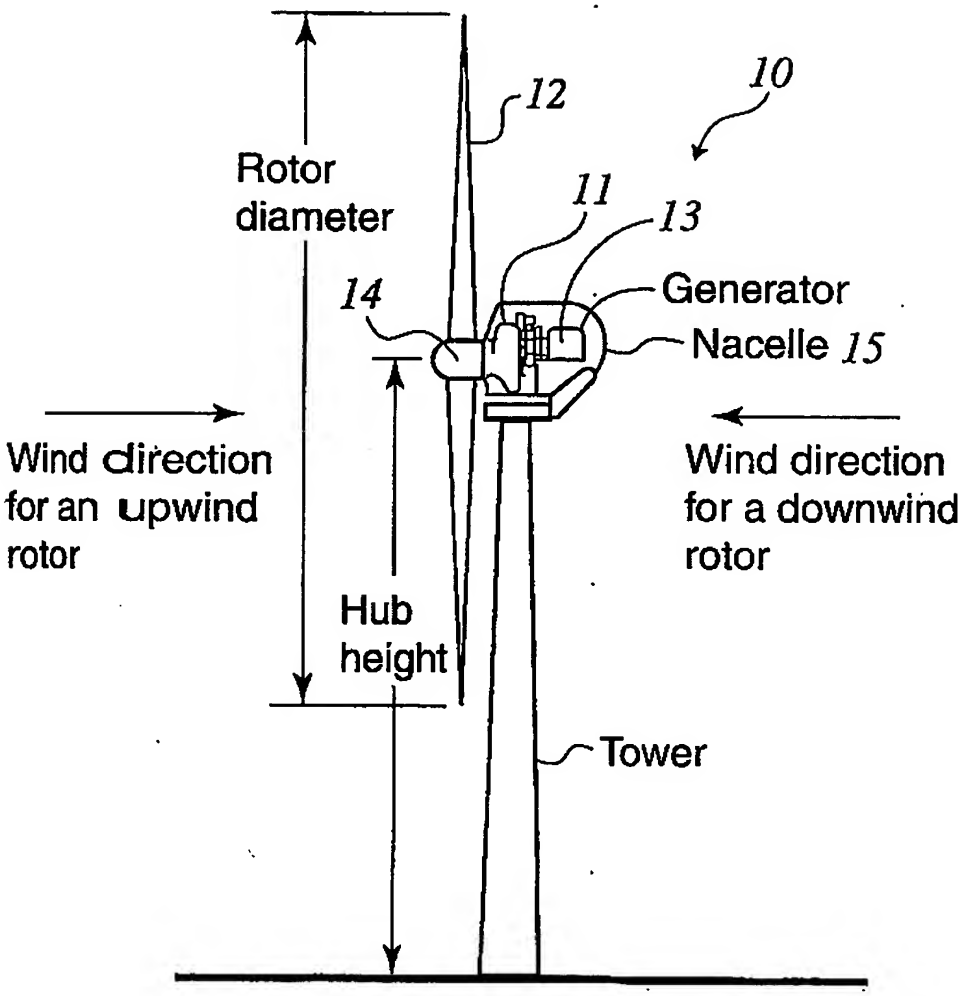
10
12
11
13
14
Generator
Nacelle 15
Rotor diameter
Wind direction for an upwind rotor
Wind direction for a downwind rotor
Hub height
Tower

FIG. 1

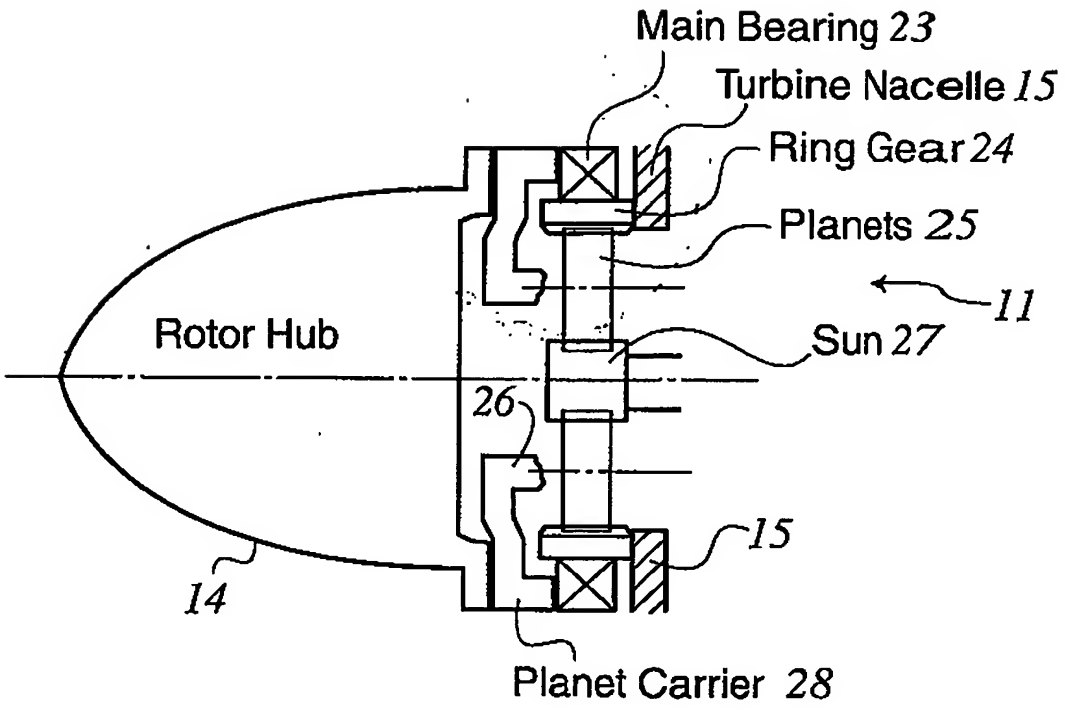
Main Bearing 23
Turbine Nacelle 15
Ring Gear 24
Planets 25
11
Rotor Hub
Sun 27
26
15
14
Planet Carrier 28

FIG. 2

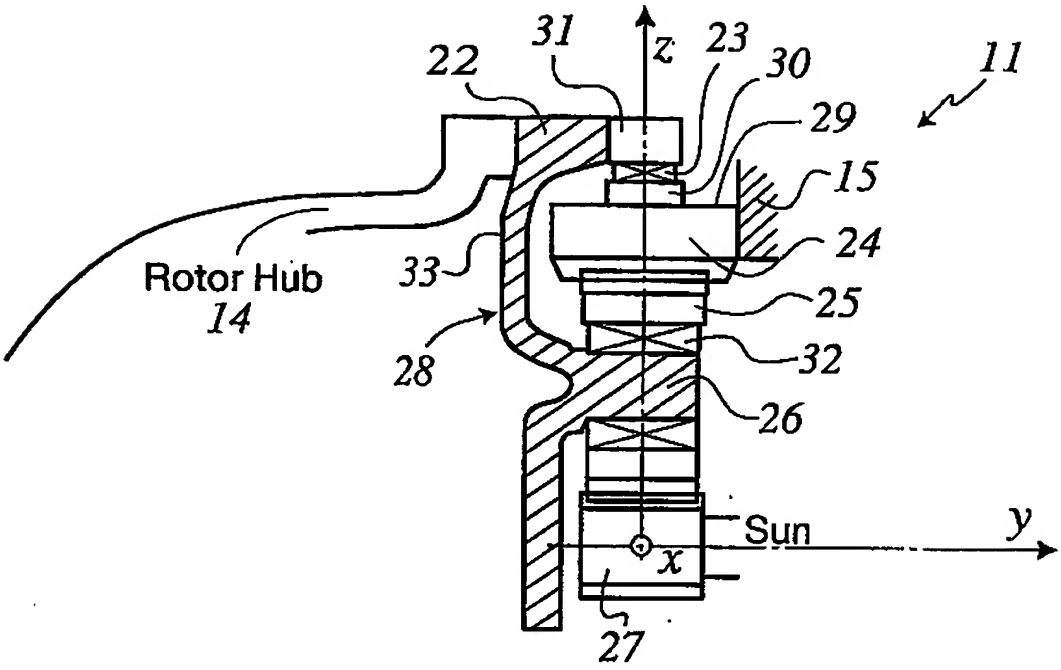

FIG. 3

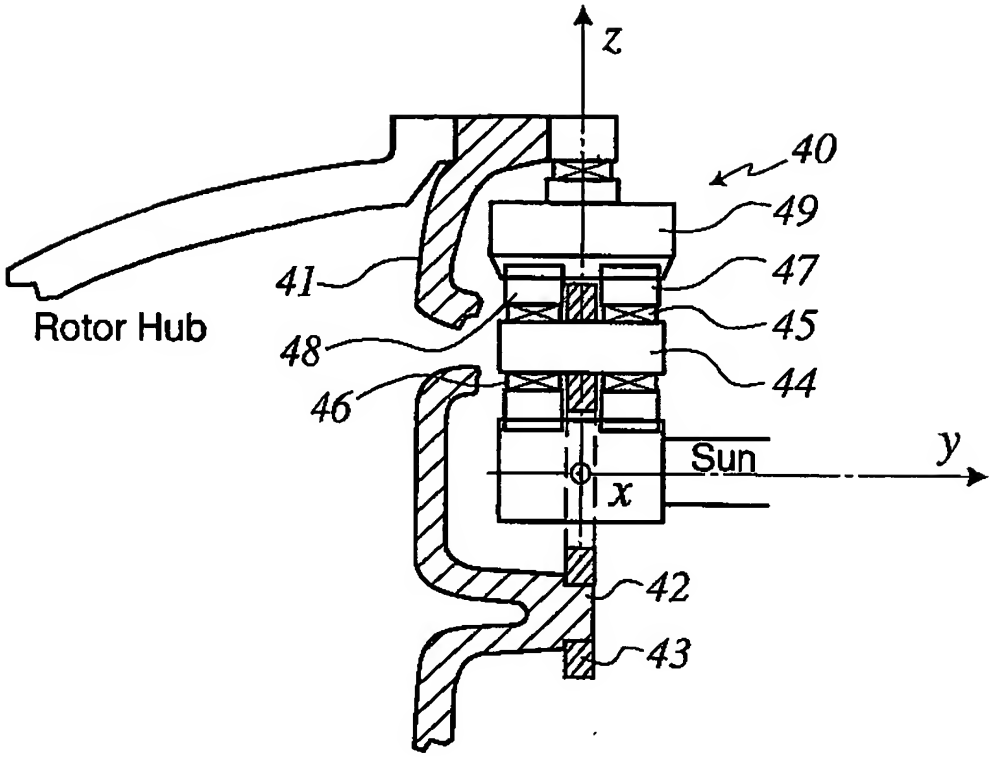

FIG. 4

INTERNATIONAL SEARCH REPORT

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PCT/IB 03/03754

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16H1/28 F03D11/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16H F03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 02 14690 A (HANSEN TRANSMISSIONS INTERNAT ;BOGAERT ROGER (BE); FLAMANG PETER () 21 February 2002 (2002-02-21) page 5, paragraph 1 -page 6, paragraph 2 figures 1-4	1-10
X	WO 96 11338 A (HEHENBERGER GERALD) 18 April 1996 (1996-04-18) figures 3-7	1-6,9,10
A		7,8
X	DE 22 35 448 A (FLENDER A F & CO) 7 February 1974 (1974-02-07) page 4 figures 1,2	1-6,9,10

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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